FINAL-ER 40 – Electrician Regulations Answer Schedule

Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. This schedule sets out the expected answers to the examination questions. The marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.

3. Symbols and terms - alternatives

Power	W or P
Voltage	V or E or U
Phase	Active

Question 1		*Marks*	*Reference*	*Marking notes*
(a)	• The owner or occupier (of the property)	(1 mark)	ESR 19(2)	
	• The Secretary.	(1 mark)	ESR 19(2)	
(b)	Any FOUR of:	(2 marks)		
	• Work carried out in accordance with Part 1 of AS/NZS 3000.		ESR 70(1)	
	• Work on installations that operate at high voltages.		ESR 70(1)	
	• Mains		ESR 4	
	• MEN switchboards		ESR 4	
	• Main earthing system		ESR 4	
	• Work on the installation of mains parallel generation systems:		ESR 70(1) ESR 72(2)(a)	
	• Work in hazardous areas:		ESR 70(1) ESR 72(2)(b)	
	• Work on installations intended for use with medical electrical appliances:		ESR 70(1) ESR 72(2)(c)	
	• Work on animal stunning appliances or meat conditioning appliances.		ESR 70(1) ESR 72(2)(e)	
(c)	Any ONE of:	(2 marks)		
	• There must be a gap of 0.6 metres		AS/NZS 3000: Figure 2.18	
	• Between the opposite wall and the fully open door of the switchboard cupboard.		AS/NZS 3000: Figure 2.18	

Question 1			*Marks*	*Reference*	*Marking notes*
	- Arranged so as to provide sufficient space for the replacement of individual items - Arranged so as to provide sufficient space for the operation, testing, installation, maintenance and repair - Access is not obstructured by the structure or contents of the building. - Be provided with adequate space around the switchboard on all sides where persons are to pass to enable electrical equipment to be operated. - Be provided with sufficient exit facilities - Shall be capable of being secured in the open position. - Shall be readily accessible			AS/NZS 3000: 2.9.2.1(c) AS/NZS 3000: 2.9.2.1(c) AS/NZS 3000: 2.9.2.2(a) AS/NZS 3000: 2.9.2.2(a) AS/NZS 3000: 2.9.2.2(a) AS/NZS 3000: 2.9.2.2 AS/NZS 3000: 2.9.2.3(a)	
(d)	Any ONE of: - Red, white and dark blue - Brown, black and grey		(2 marks)	AS/NZS 3000: Figure 3.2	To gain marks, one set of colours must be accurately stated form figure 3.2
(e)	(i)	- 6 mm^2	(½ mark)	AS/NZS 3000 3.12.2.2	
		- 7 strands	(½ mark)	AS/NZS 3000 3.12.2.2	
	(ii)	16 mm^2	(1 mark)	AS/NZS 3000 : Table 3.9	
(f)	- It shall operate directly in the circuit wiring to the heater elements.		(1 mark)	AS/NZS 3000: 4.8.2.2	
	- It shall not be arranged for control through relays or contactors		(1 mark)	AS/NZS 3000: 4.8.2.2	
(g)	Any ONE of:		(2 marks)		

Question 1	*Marks*	*Reference*	*Marking notes*
• It must be provided with a means to prevent automatic restarting after stopping		AS/NZS 3000: 4.13.1.4	
• Suitable protective measures shall be taken where: - the loss and subsequent restoration of voltage, or - a drop in voltage Could cause danger to persons or property.		AS/NZS 3000: 2.8.1	
(h) Any FOUR of: • Water • Gas • Flammable liquids • Sprinkler pipe • Other conductive non-electrical service enclosure	(2 marks)	AS/NZS 3000: 5.3.2.2	
(i) (i) Full penetration of 12.5 mm diameter sphere not allowed. The jointed test finger shall have adequate clearance from hazardous parts.	(1 mark)	AS/NZS 3000: Table G1a	
(ii) Protected against water splashed from all directions. Limited ingress permitted.	(1 mark)	AS/NZS 3000: Table G1b	
(j) (i) 85 metres	(1 mark)	AS/NZS 3000: Table B1	
(ii) 136 metres	(1 mark)	AS/NZS 3000: Table B1	

Question 2	*Marks*	*Reference*	*Marking notes*
(a) (i) • Part 2	(½ mark)	ESR 60(1)	
• AS/NZS 3000	(½ mark)	ESR 60(1)	
(ii) A declaration of conformity	(1 mark)	ESR 57(2)(a)	
(iii) A certificate of compliance	(1 mark)	ESR 67(1)	
(iv) Mains work	(1 mark)	ESR 70(1)(c)	
(v) AS/NZS 3000	(1 mark)	ESR 65(1)	
(b) Any FIVE of:	(5 marks)		
• Ensure that the polarity of the supply is correct		ESR 73(2)(a)(i)	
• Ensure that the protection of the supply is correctly rated		ESR 73(2)(a)(ii)	
• Ensure that the installation is compatible with the supply system.		ESR 73(2)(a)(iii)	
• Verify that there is a main earthing system		ESR 73(2)(a)(iv)	
• Confirm that there is a declaration of conformity for the revenue meters. Or Check and test the revenue meters		ESR 73(2)(a)(v)	
• Sight a certificate of compliance.		ESR 73(2)(b)	

Question 3	*Marks*	*Reference*	*Marking notes*
(a) Any TWO of:	(2 marks)		
● It is the electrical interface between the network and the installation		GK	
● It provides for the operation of all or part of the installation.		GK	
● Contains protection devices for final subcircuits.		GK	
● Contains the MEN connection.		GK	
● An assembly of circuit protective devices for the protection of submains and final subcircuits		AS/NZS 3000: 1.4.91	
● The supply to the whole electrical installation can be controlled		AS/NZS 3000: 1.4.92	
● Provided for the primary control and protective devices of an installation		AS/NZS 3000: 2.9.1	
(b) Any TWO of:	(2 marks)	AS/NZS 3000: 2.9.2.5(j) Exception	
● Has a degree of protection of IPX4.			
● A shield is provided to prevent water spraying on it.			
● Sprinkler heads are provided with suitable deflectors			
● Sprinkler heads are of the dry type.			
(c) Any TWO of:	(2 marks)		
● The wiring must be provided with sufficient free length to allow the panel to be moved into a position to enable work to be carried out.		AS/NZS 3000: 2.9.6(a)	
● To avoid undue movement or stress at terminals of electrical equipment when the panel is moved or is fixed in position.		AS/NZS 3000: 2.9.6(b)	
● Arranged to prevent undue pressure on electrical equipment mounted on the panel.		AS/NZS 3000: 2.9.6(c)	
● The hinged components of the framework are connected by means of a flexible protective earthing conductor		AS/NZS 3000: 5.3.2.3(c)(ii)(B)	
(d) (i) (A) ● Yes	(½ mark)		

Question 3	*Marks*	*Reference*	*Marking notes*
• AS/NZS 3000: 5.3.4 (B) • Yes • AS/NZS 3000: 5.3.5.1	(½ mark) (½ mark) (½ mark)		
(ii) • Protective earthing conductors • Main earthing conductor • MEN connection • Equipotential bonding conductors	(2 marks)	AS/NZS 3000: 5.3.4	

Question 4	*Reference Marks*	*Marking notes*
		Accept any solution that shows the heaviest loaded phase to be between 105A and 125A

(a)

Load Group	Calculation	Load on each phase (amps)			
		R	W	B	
Group A					
38W Fluorescent fittings	12 x (38 ÷ 230) = 1.98				(½ mark)
		1.98			(½ mark)
75W, fluorescent lights	30 ÷ 2 = 15 15 x (75 ÷ 230) = 4.95				(½ mark)
		9.78			(½ mark)
Group B					
10A Socket outlets	(1 x 1000) + (8 x 750) = 7000				(½ mark)
2 phases 9 per phase.	÷ 230 = 30 .44		30 .44	30 .44	(1 mark)
15A socket outlets	(1 x 15) + (2 x 15 x 0.75) = 37.5				(½ mark)
3 phases.					(1 mark)
3 per phase		37 .5	37 .5	37 .5	
Group D					
9 kW Motors 5 kW Chillers	15.8A + (0.75 x 15.8A) = (0.5 x 2 x7.25)				(½ mark)
	= 15.8 + 11.85 + 7.25 = 34.9				(½ mark)
		34.9	34.9	34.9	(1 mark)
Group G					
5 kW water heater	(5000 ÷ 230) = 21.74		-	-	(½ mark)
		21.74			(½ mark)
Total					(1 mark)
		105.9	102.84	102.84	

(b) Load on highest loaded phase =- 105.9A

Question 5	*Marks*	*Reference*	*Marking notes*
(a) The sequence is as follows:			
1. Earth resistance test – continuity of main earthing conductor	(½ mark)	AS/NZS 3000: 8.3.4	
2. Earth resistance test for other earthed equipment and equipotential bonded parts	(½ mark)	AS/NZS 3000: 8.3.4	
3. Insulation resistance test of the installation	(½ mark)	AS/NZS 3000: 8.3.4	
4. Consumers mains test – polarity	(½ mark)	AS/NZS 3000: 8.3.4	Tests 4 to 6 can be carried out in any order
5. Submains test – polarity	(½ mark)	AS/NZS 3000: 8.3.4	
6 Final subcircuit tests – • polarity • connections	(½ mark)	AS/NZS 3000: 8.3.4	
7 Earth fault-loop impedance test	(½ mark)	AS/NZS 3000: 8.3.4	
8 Verification of operation of residual current devices	(½ mark)	AS/NZS 3000: 8.3.4	
(b) • The first three tests confirm that the installation has been correctly installed.	(1 mark)		Accept any other reasonable answer
• The subsequent tests rely on the installation being correctly installed so valid test results can be obtained.	(1 mark)		
(c) (i) • Verification of operation of residual current devices.	(½ mark)	GK	
• Earth fault-loop impedance test	(½ mark)	GK	
(ii) • Consumers mains test – polarity	(½ mark)	GK	
• Submains test – polarity	(½ mark)	GK	
• Final subcircuit tests – • polarity • connections	(½ mark)	GK	
(iii) • Earth resistance test – continuity of main earthing conductor	(½ mark)	GK	

Question 5	*Marks*	*Reference*	*Marking notes*
- Earth resistance test for other earthed equipment and equipotential bonded parts	(½ mark)	GK	
- Insulation resistance	(½ mark)	GK	

Question 6	*Marks*	*Reference*	*Marking notes*
(a) (i) • No	(½ mark)		
AS/NZS 3000: 2.6.3.4, Exception (b)	(½ mark)		
(ii) • At the origin (or switchboard)	(½ mark)		
AS/NZS 3000: 2.6.3.1	(½ mark)		
(iii) • No	(½ mark)		
AS/NZS 3000: 2.6.3.4	(½ mark)		
(iv) Any ONE of:			
• No	(½ mark)	AS/NZS 3000: 2.6.3.4	
Provided the new socket outlets have in-built RCD protection	(½ mark)		
• Yes		AS/NZS 3000: 2.6.3.4	
If the new socket outlets do not have in-built RCD protection			
(v) • The socket outlet is located in a position that it is not likely to be accessed for general purposes.	(1 mark)	AS/NZS 3000: 2.6.3.1 Exception 3(a)	
• The socket outlet is clearly marked to indicate the restricted purpose of the socket outlet and that RCD protection is not provided	(1 mark)	AS/NZS 3000: 2.6.3.1 Exception 3(b)	
(b) (i) • Type A	(½ mark)	AS/NZS 3000: 2.6.2.2 Note: 2(b)	
• 10 mA	(½ mark)	AS/NZS 3000: 2.6.3.2.2(c)	
(ii) • Type A	(½ mark)	AS/NZS 3000: 2.6.2.2 Note: 2(b)	

Question 6	*Marks*	*Reference*	*Marking notes*
- 30mA	(½ mark)	AS/NZS 3000: 2.6.3.1	
(c) (i) 3	(½ mark)	AS/NZS 3000: 2.6.2.4(b)	
(ii) All final circuits except the range and hot water cylinder final circuits	(1½ marks)	AS/NZS 3000: 2.6.2.4	

Question 7		Marks	Reference	Marking notes
(a)	Section view A-A			
	- Zone 1 shown as being between the shower base and 2.25 metres high	(½ mark)	AS/NZS 3000: Figure 6.8	
	- Zone 2 shown as 0.6 metres out from the edge of the shower and 2.25 metres high	(½ mark)	AS/NZS 3000: Figure 6.8	
	- Zone 3 shown as 2.4 metres out from Zone 2 and 2.25 metres high	(½ mark)	AS/NZS 3000: Figure 6.8	
	Plan view			
	- Zone 0 shown as the internal part of the shower tray	(½ mark)	AS/NZS 3000: Figure 6.7	
	- Zone 1 shown as the rim of the shower tray	(½ mark)	AS/NZS 3000: Figure 6.7	
	- Zone 2 shown as 0.6 metres out from the shower door, going round the fixed partition	(½ mark)	AS/NZS 3000: Figure 6.7	
	- Zone 3 shown as 2.4 metres out from Zone 2, going round the fixed partition	(½ mark)	AS/NZS 3000: Figure 6.7	
(b)	Section view A-A			
	Zone 2 (basin) shown as being: - 1 metre above basin. - 0.5 metres either side of the basin	(½ mark)	AS/NZS 3000: Figure 6.11	
	Plan view			
	- Zone 0 shown as the internal part of the basin	(½ mark)	AS/NZS 3000: Figure 6.11	
	- Zone 2 shown as 0.5 metres either side of the basin	(½ mark)	AS/NZS 3000: Figure 6.11	
(c)	(i) The socket outlet must be shown:			
	- The socket outlet must be shown outside Zone 2 of the hand basin; and	(½ mark)	AS/NZS 3000: 6.2.4.2(c)	
	- More than 300mm above the floor	(½ mark)	AS/NZS 3000: 6.2.4.2(c)	
	(ii) - Protected by a RCD rated at 30mA	(1 mark)	AS/NZS 3000: 6.2.4.2(c)(i)	

Question 7	*Marks*	*Reference*	*Marking notes*
- Supplied individually as a separated circuit	(1 mark)	AS/NZS 3000: 6.2.4.2(c)(ii)	
(d) (i) IPX7	(½ mark)	AS/NZS 3000: 6.2.4.1(a)	
(ii) IPX4	(½ mark)	AS/NZS 3000: 6.2.4.1(b)	
(iii) IPX4	(½ mark)	AS/NZS 3000: 6.2.4.1(b)	
(iv) None	(½ mark)	AS/NZS 3000: 6.2.4.1(c)	

Question 8	*Marks*	*Reference*	*Marking notes*
(a) • Automatically disconnect the supply on the occurrence of a fault likely to cause a current flow through a body in contact with exposed conductive parts, where the value of that current is equal to or greater that the shock current.	(½ mark)	AS/NZS 3000: 1.5.5.2(a)	
• Prevent a fault passing through a body by the use of Class II equipment or equivalent insulation	(½ mark)	AS/NZS 3000: 1.5.5.2(b)	
• Prevent a fault passing through a body by the use of electrical separation (isolation) of the system	(½ mark)	AS/NZS 3000: 1.5.5.2(c)	
• Limit the fault current that can pass through a body to a value lower than the shock current.	(½ mark)	AS/NZS 3000: 1.5.5.2(d)	
(b) Any TWO of: • Automatic disconnection When a fault current flows, this operates the protective device by blowing a fuse or tripping an MCB or an RCD to disconnect the supply. • Double insulation The use of double insulation construction makes it impossible to touch exposed conductive parts that may be live. • Electrical separation The use of electrical separation to supply the load removes any reference to earth on the supply. If an earth fault occurs there will be no voltage or current to earth. • Limit fault current The use of an ELV supply to reduce the fault current to below the IEC shock current limits.	(4 marks)		The explanations must relate to two statements made in (a) Accept any statement from AS/NZS 3000 if it is the equivalent of any of these answers.

Question 8	*Marks*	*Reference*	*Marking notes*
(c) ● Automatic disconnection Any ONE of: - Verify the earth fault loop impedance value is below the maximum permitted for the cable size used and the protective device rating used to supply the final subcircuit. - Use of test equipment that causes the RCD to operate under residual a.c current and residual pulsating d.c current and that verifies that the RCD is suitable for personal protection. ● Double insulation Any ONE of: - Ensure that the double insulation is free from mechanical damage. - Carry out an insulation resistance test between the insulation and any exposed metal to verify the integrity of the insulation - Carry out an earth leakage test to verify the integrity of the insulation ● Electrical separation Verify the separation insulation resistance values; primary winding to earthed case; primary winding to secondary winding; and secondary winding to earthed case are at least 1 MΩ. ● Limit fault current Verify that the ELV supply is below 50V in dry locations; below 25V in damp locations and under 12V when submerged in water.	(4 marks)		The explanations must relate to the statements made in (b)

Question 9	*Marks*	*Reference*	*Marking notes*
(a) $I_L = \frac{P}{\sqrt{3} \times 400}$	(½ mark)		
$I_L = \frac{63000}{\sqrt{3} \times 40}$	(½ mark)		
$= 90.94A$	(1 mark)		
From Tables 27(2) the rating factor is 1.00	(1 mark)		
From Table 12, column 14, rating of 16 mm^2 is 106A	(1 mark)		
A 16 mm^2 cable will meet the load requirements	(1 mark)		
(b) Maximum volt drop permitted is 400 x 0.025 = 10V.	(½ mark)		
$V_d/A.m = \frac{V_d \times 1000}{I \times L}$	(½ mark)		
$= \frac{10 \times 1000}{90.86 \times 15.7}$	(½ mark)		
$= 7\ V_d/A.m$	(½ mark)		
From Table 42, a 6.49 $V_d/A.m$ a 6 mm^2 cable	(½ mark)		
Volt drop $= \frac{V_d/A.m \times I \times L}{1000}$ $= \frac{6.49 \times 90.94 \times 15.7}{1000}$			
$= 9.27V$	(½ mark)		
Therefore a 6 mm^2 cable will meet the voltage drop requirements	(1 mark)		
(c) A 16 mm^2 cable will meet the voltage drop and load requirements	(1 mark)		